



Pickit
ROBOT VISION MADE EASY

Integration Manual

September 2017



ROBOT VISION MADE EASY

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You can find additional information, FAQ, how-to guides and articles on:

<http://support.pickit3d.com>

1 Preface

Pick-it™ is a 3D vision application for picking a broad family of products in any location with any robot. Pick-it can be used for locating objects during palletizing, depalletizing, order picking, machine tending or assembly tasks with a robot or machine.

WARNING Text in a red-colored box should always be read and understood.

NOTE Important hints for correct operation of Pick-it™ are written in yellow boxes.

In this document, the terms '**Vision System**', '**Pick-it™ Vision System**' or '**Pick-it™**' all refer to the same device, a 3D camera processor unit with 3D camera and calibration tools.

The terms '**Sensor**' or '**Camera**' all refer to the same device, the 3D camera in use by the Pick-it™ Vision System.

2 Safety

The OPERATOR must have read and understood all the instructions in the following manual before handling the Pick-it™ Vision System.

The term OPERATOR refers to anyone responsible for any of the following operations on Pick-it™ and associated robot or tools:

- Installation
- Control
- Maintenance
- Inspection
- Calibration
- Programming
- Decommissioning

This documentation explains the various components of the Pick-it™ Vision System, as well as general operations regarding the entire life-cycle of the product; from installation to operation and decommissioning.

The drawings and photos in this document are representative examples and may differ from the delivered product.

2.1 Warning

Note

Any use of the Pick-it™ Vision System in noncompliance with these warnings is inappropriate and may cause injury or damage.

2.1.1 Machine Safety Warning

At all times, dedicated safety device(s) must be considered when the Vision System is connected to a robot or machine. Sensor failure can occur and result in danger for workers or machinery if not properly secured. See local or international regulations for machine safety.

2.1.2 3D Camera Warning

- The Camera needs to be properly secured before operating the robot.
- Do not install or operate a Camera that is damaged or lacking parts.
- Always respect the Camera's electrical and power supply specifications.
- Make sure all cord sets are always secured at both ends, at the Camera and at the robot.
- Always respect the recommended keying for electrical connections.
- Be sure no one is in the robot path and/or Camera field of view before initializing the robot's routine.
- Any use of the Camera in noncompliance with these warnings is inappropriate and may cause injury or damage.



CAUTION: Pick-it camera calibration

The Pick-it factory calibration is important to guarantee the accuracy over the Field Of View range.

Opening the camera will result in bad performance.

Warranty is LOST when calibration seal is broken.

2.2 Intended use

The Pick-it™ Vision System is designed for locating objects in a region of interest which will be grasped or manipulated by a robot or machine.

The product is intended for installation nearby or on a robot or other automated machinery and equipment.

WARNING Pick-it™ is a sensor for a robotic application. Safe motions of the robot must always be checked by the robot itself and can never be guaranteed by Pick-it™.

Always comply with local and/or national laws, regulations and directives on automation safety and general machine safety.

The unit may be used only within the range of its technical specifications. Any other use of the product is deemed improper and unintended. Pick-it will not be liable for any damages resulting from any improper or unintended use.

3 Installation and Setup

This Chapter contains the basic steps you will need to take in order to get your Pick-it™ system operational.

3.1 Scope of Delivery

Standard upon delivery (**PICK-IT-KIT-001**):



- Pick-it™ Robot Vision Software Module FLEX and/or TEACH
- Pick-it™ Vision (FLEX) Processor or Vision PLUS (TEACH) unit with power supply
- Pick-it™ 3D Camera
- A 2m 3D Camera Device Cable (**CBL-USB-2**)
- A 5m or 10m USB repeater cable (**IMPORTANT**: Always connect this cable between the 2m camera cable and the processor)
- Set of 3 Workspace Markers (**ACC-WSP-3WAY**)
- Robot-to-Camera Calibration Plate (**ACC-ROB-CAL-001**)

NOTE The following are not included in delivery unless specified in the purchase:

- Options such as couplings and adapters for mounting the 3D Camera on various industrial robots.

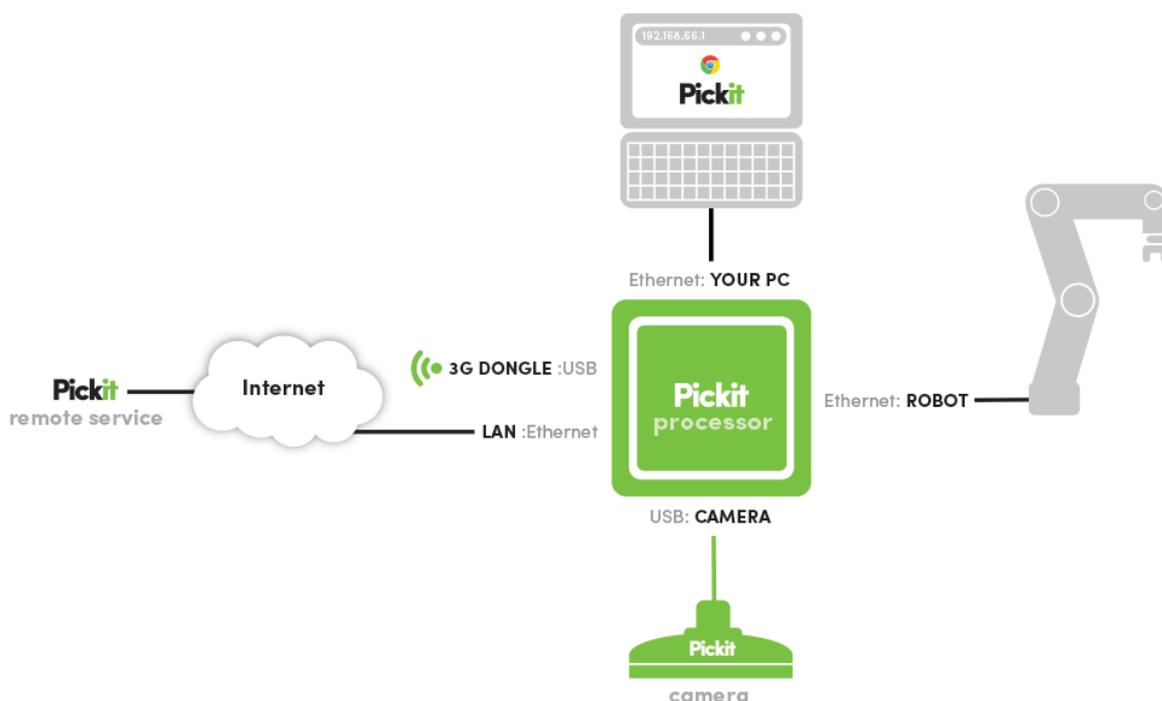
3.2 Connecting Pick-it

A. Overview

An operational Pick-it™ system consists of 3 mandatory components:

- 3D Camera
- Vision Processor
- Robot

For set-up, an external PC or laptop is to be used to configure the Pick-it™ processor. After the configuration, the external PC or laptop can be removed.

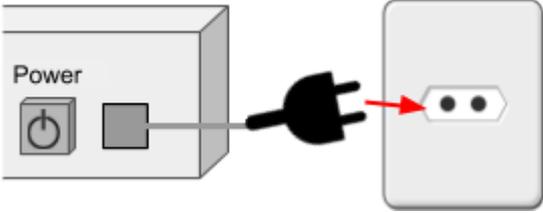
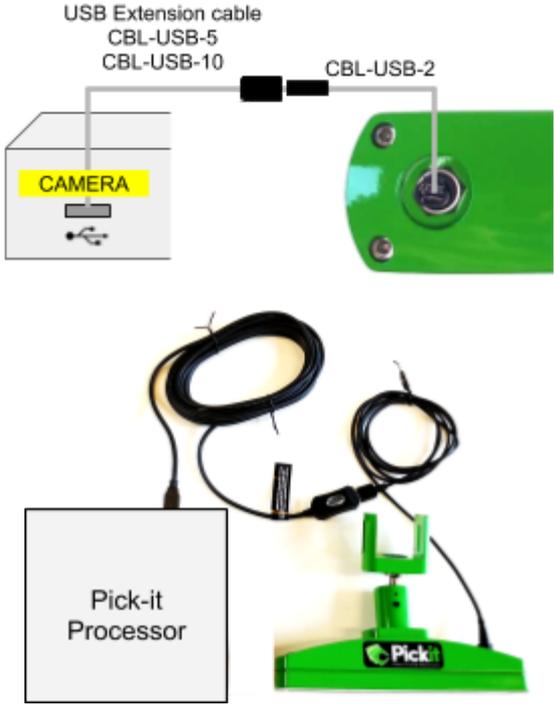
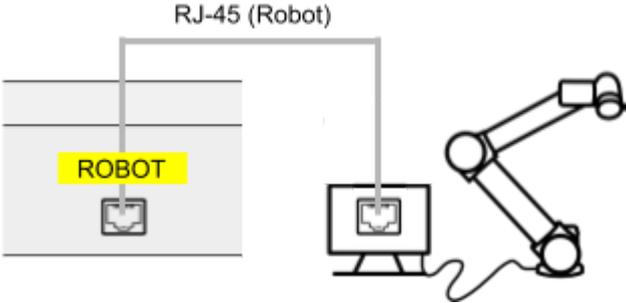


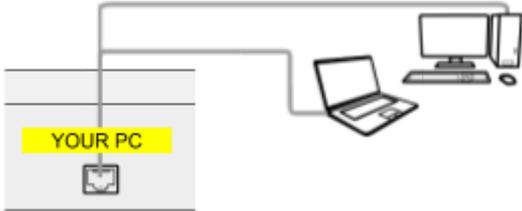
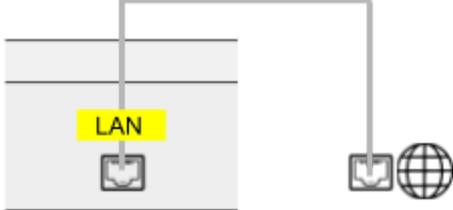
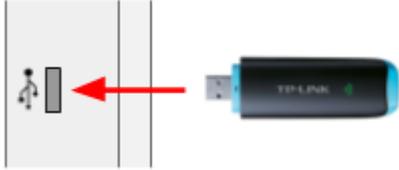
There are two mandatory connections and two optional connections for Pick-it™:

- **Top:** The Pick-it™ vision processor **can be connected** via a network cable to any PC for access to the Pick-it™ web interface via a **CHROME** browser.
- **Bottom:** The Pick-it™ camera **must be connected** to the Pick-it™ vision processor using the provided 2m USB camera cable **and** the 5m repeater cable.
- **Right:** The Pick-it™ vision processor **must be connected** with a network cable to the robot or machine controller. This connection allows the robot and Pick-it™ to exchange commands, status information, object poses and the robot pose.
- **Left:** The Pick-it™ vision processor **can be connected** via a network cable to the company network in order to receive remote service from an Pick-it service engineer over the Internet. Alternatively it can be connected through the Pick-it 3G USB dongle.

B. Cable Connections

The images in this Section show the cabling procedure for a generic Pick-it processor with labelled ports. Depending on the purchased vision engine, the Pick-it™ processor is either a FLEX or an TEACH system. Please refer to [Annex 1: Cabling and powering for FLEX and TEACH processors](#) for the processor-specific location of the ports and connectors.

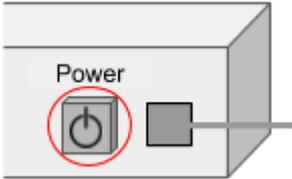
<p>Connect the Pick-it™ processor to the power supply: The power cabling procedure depends on the computer.</p>	
<p>Connect the camera to the Pick-it™ processor: Use the CBL-USB-2 cable that is provided with Pick-it™ and plug it into the female end of the extension cable. Plug the male end of the extension cable to the indicated CAMERA USB port.</p> <p>IMPORTANT: The use of the extension cable 5 M (CBL-USB-5) or 10M (CBL-USB-10) is ALWAYS required.</p> <p>A separate power supply for the camera is not required.</p> <p>A USB hub is not allowed between the Pick-it™ processor and camera.</p>	
<p>Connect the robot or machine controller to the Pick-it™ processor: Use a standard UTP network cable and connect it to the RJ45 port labelled with ROBOT.</p>	

<p><i>Only required for setup</i> Connect a computer to the Pick-it™ Interface: To configure the Pick-it™ software, connect a computer to the RJ45 port labelled with 'Your PC' and open the Pick-it™ web interface by surfing to 192.168.66.1 to configure your Pick-it™ setup.</p>	
<p><i>Required for remote servicing</i> Connect the processor's LAN port to the company network: To enable the system to be remotely updated and serviced, plug a network cable into the LAN port of the processor and connect it to your router or switch providing Internet access.</p>	
<p><i>Required for wireless remote servicing</i> Connect the 3G USB dongle to the 3G dongle USB port of the processor: To enable wireless remote servicing, plug the 3G USB dongle. A solid green led indicates that device has successfully connected to the internet. In case of problems connecting the dongle, refer to http://support.pickit3d.com/article/25-getting-ready-for-remote-service.</p>	

NOTE The standard length of the USB repeater cable for connecting the camera is **5.0 m (15ft) (ref CBL-USB-5)**. In case 5.0 m is not enough, contact your Pick-it™ sales contact to provide a solution.

C. Powering on the system

By default, the Pick-it™ processor needs to be turned on by pressing the button as shown below. Please refer to [Annex 1: Cabling and powering for FLEX and TEACH processors](#) for the computer-specific location of the power button or switch.

<p>You can turn on the processor manually by shortly pressing the Power/Reset button/switch. To turn it off, you need to press again the same button. If after pressing the button the computer does not turn off, keep it pressed until it does.</p>	
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D. Ethernet TCP/IP Setup

NOTE Prior to starting, ensure you have correctly completed all the steps in “**3.3.B Cable Connections**”.

The Pick-it system uses TCP/IP to connect to your robot and your laptop/PC. You need to connect and setup your TCP/IP network correctly in order to operate a Pick-it system.

Pick-it Port Label	Pick-it Port IP Address & subnet mask	Connects to	Remarks
INTERFACE - YOUR PC	192.168.66.1 & 255.255.255.0	Your laptop or computer	<ul style="list-style-type: none"> Will offer an IP address to any computer directly connecting to it (using DHCP). Once connected, access the Pick-it™ interface using the 192.168.66.1 address.
ROBOT	169.254.5.180 & 255.255.0.0	The robot	<ul style="list-style-type: none"> For a simple set up, choose a static IP connection on the robot and set the robot's IP address to e.g. 169.254.5.182 and 255.255.0.0 as the subnet mask. The default port number is 5001. The Pick-it IP address can be configured via the Pick-it web interface but <u>can not</u> be set to 192.168.0.X or 10.X.Y.Z and can not be the same as the Pick-it IP address.
LAN	Provided by your router's DHCP server	An Internet router in your company network	<ul style="list-style-type: none"> In order to allow remote servicing, this port needs to be plugged into a LAN segment of your company with access to Internet. If your company uses firewall, ask your system administrator to whitelist the LAN port's MAC address shown in the Network configuration page. This Pick-it connection can be configured via the Pick-it web interface.

The settings for the Pick-it ROBOT and LAN ports can be configured using the 'NETWORK' config page of the Pick-it web interface. See Section 3.6, [Network configuration](#).

3.3 The User Interface

After connecting a laptop or PC to the Pick-it™ port labelled INTERFACE - YOUR PC as explained in the [Connecting Pick-it](#) Section (3.2), the user interface can be accessed by opening an Internet browser and browsing to the Pick-it™ website:



192.168.66.1



WARNING The only supported internet browser for Pick-it™ is **Google Chrome**.

Note also that the Pick-it™ web interface requires WebGL to be able to show 3D visualizations. In case the 3D views don't work out-of-the-box, check your GPU state by going to the following link: **chrome://gpu**.

If it doesn't read "WebGL: Hardware accelerated" in the first list, this confirms that the 3D views won't work. To resolve this issue, you have to:

- Make sure **chrome://flags/#disable-webgl** is disabled (there should be a link "Enable")
- If that does not help, try to additionally enable **chrome://flags/#ignore-gpu-blacklist**.

To confirm that this fixes the problem, go to the page <https://get.webgl.org/> and make sure you see the spinning cube. If that's not the case, use a different PC or laptop (with a preferably stronger graphics card) to access the web interface in order to see the 3D views).

If the Pick-it™ web interface does not appear, check whether the processor is turned on (blue power led is on) and verify that the laptop or tablet reports a connected network interface.

3.3.1 The Pick-it connection status

The Pick-it™ connection status is indicated in the top status bar:

- **Robot:** An active robot communication is indicated by ✓, otherwise ∅.
- **Cam:** A correct camera connection is indicated by ✓, otherwise ∅.
- **App:** The Pick-it™ application correctly working is indicated by ✓, otherwise ∅.

3.3.2 The Pick-It modes

The four main operational modes of Pick-it are:

- **Running:** Pick-it is ready to receive commands from the robot and to send localization results to the robot. You can only run a robot program with Pick-it when this state is activated.
- **Check:** Pick-it is doing a single object detection without sending the result to a connected robot. This allows to test the object detection without any robot or machine connected.
- **Testing:** Pick-it is continuously detecting objects without sending the result to a connected robot. This mode allows to test the object detection without any robot or machine connected.
- **Idle:** Reached after a 'STOP'. No commands from the robot are accepted.

By default, Pick-it™ enters the **Running** mode upon startup.

3.3.3 The Pick-It menu

The following **views** are available:

1. **2D:** continuous image stream from the 2D camera
2. **3D:** continuous pointcloud stream from the 3D camera
3. **POINTS:** pointcloud resulting from the latest localisation cycle
4. **CLUSTERS:** pointcloud resulting from the latest localisation cycle
5. **OBJECTS:** pointcloud resulting from the latest localisation cycle

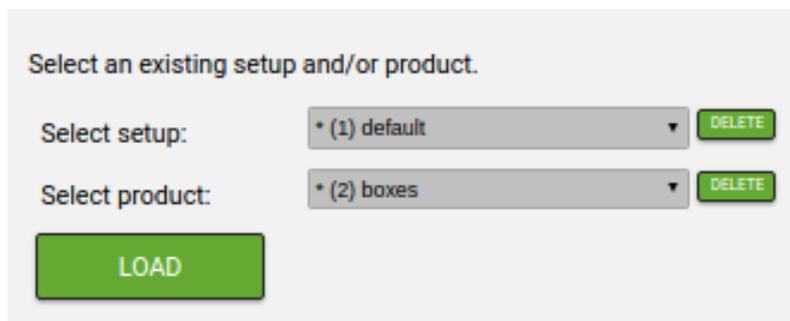
The following **configuration pages** are available:

6. **CONFIGURATION:** this page allows to select the basic configuration
7. **REGION OF INTEREST:** this page allows to define the region of interest
8. **ROBOT SETUP:** this page allows to perform robot camera calibration
9. **DETECTION:** this page allows to configure the localization algorithm
10. **PICKING STRATEGY:** this page allows to configure some aspects of the picking strategy
11. **NETWORK:** this page allows to configure the LAN and Robot network interfaces
12. **FILES:** this page allows you to view or download robot programs/scripts and saved scenes files

3.4 Pick-it configuration

Press the CONFIGURE button to start and configure a new Pick-it™ application. Here you can select an existing **setup** and **product type** or create new ones.

- **Setup**: a setup contains the region of interest configuration, the robot-camera calibration and the robot type.
- **Product type**: a product type contains the parameters for the actual localization algorithm.

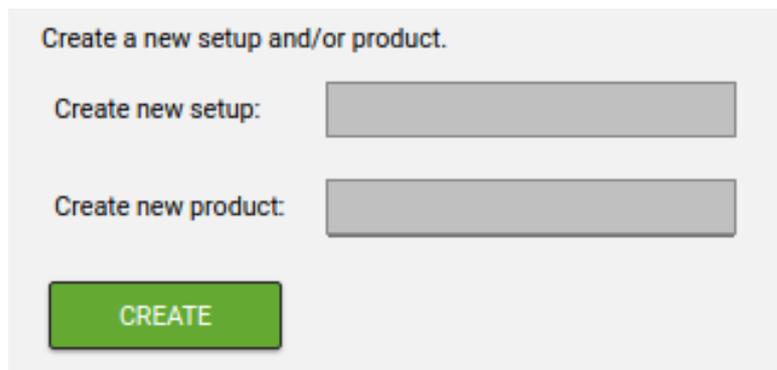


Select an existing setup and/or product.

Select setup: * (1) default

Select product: * (2) boxes

To create a new setup and product, fill in the corresponding text fields and click the CREATE button. Pick-it will make a copy of the current settings and store them under the new name.



Create a new setup and/or product.

Create new setup:

Create new product:

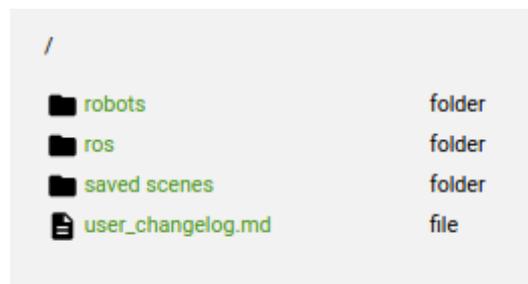
You can delete a specific setup or product by pressing the DELETE button next to the currently selected setup/product. Note that a setup or product file cannot be deleted while being loaded.

Setup and **Product** properties can only be saved to the current configuration. Therefore, a new setup and/or product should be created before starting to configure a new Pick-it™ application.

Note: creating a new setup or product makes a copy of the currently selected one.

3.5 Files

Files located on the Pick-it™ system are accessible through the FILES button in the left menu. This page allows you to browse the folder and file contents, view various robot program scripts as well as download the saved scenes.



3.6 Network configuration

The network interfaces of the Pick-it™ Processor can be configured using the **NETWORK** page. Here you can specify the system's hostname, configure the robot port (which is used to communicate with the robot) and the LAN port (which is optionally used to setup remote servicing).

Configure the network ports

This page shows the current configuration of the Pickit LAN and ROBOT ports. The LAN port needs only configuring in order to setup remote servicing, which is optional.

The ROBOT port always needs to be setup, such that Pickit can communicate with your robot.

Note: Changing the hostname will require a manual reboot of the Pickit processor.

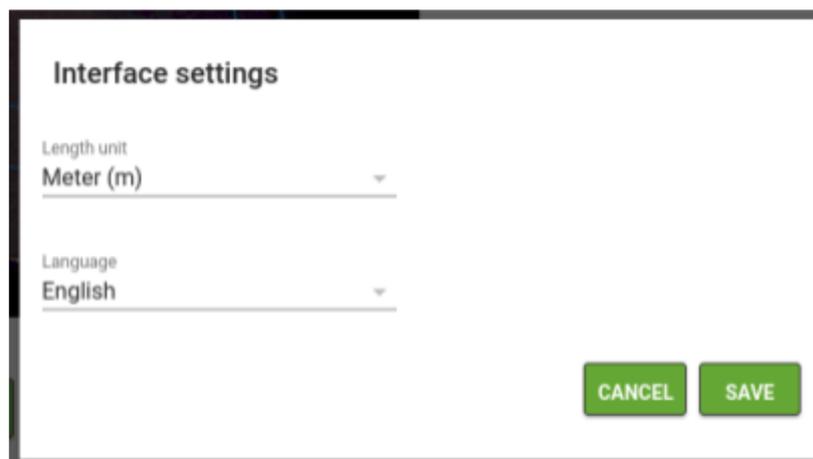
Hostname:	<input type="text" value="im-pickit-004"/>	LAN port	<input type="text" value=""/>
ROBOT port	<input type="button" value="STATIC"/>	<input type="button" value="STATIC"/>	<input type="button" value="DYNAMIC"/>
MAC Address:	<input type="text" value="00:30:64:2b:36:dc"/>	MAC Address:	<input type="text" value="00:30:64:2b:36:dd"/>
IP Address:	<input type="text" value="169.254.5.180"/>	IP Address:	<input type="text" value="192.168.168.183"/>
Netmask:	<input type="text" value="255.255.0.0"/>	Netmask:	<input type="text" value="255.255.255.0"/>
Gateway:	<input type="text" value=""/>	Gateway:	<input type="text" value="192.168.168.1"/>
DNS Server 1:	<input type="text" value=""/>	DNS Server 1:	<input type="text" value=""/>
DNS Server 2:	<input type="text" value=""/>	DNS Server 2:	<input type="text" value=""/>
DNS Server 3:	<input type="text" value=""/>	DNS Server 3:	<input type="text" value=""/>

3.7 Information and Units

3.7.1 Interface settings

You can access the interface settings dialog by clicking on the gear icon at the rightmost of the top bar. The pop-up dialog enables you to select the length unit of choice (meters, inches, ...) after which all length values in the interface will be converted to the newly selected unit.

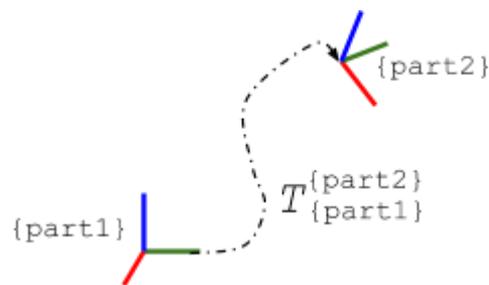
You can also choose the desired language of the interface (currently only English).



4 Frames and transformations

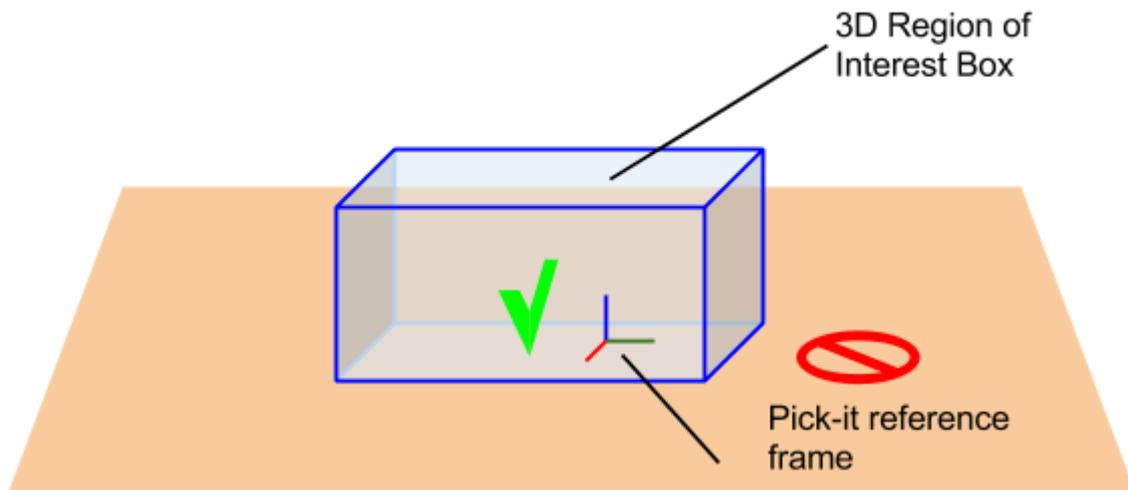
A **frame** represents the position and orientation of a part of a system by means of three orthonormal vectors and a point. Examples are the robot base frame, the end-effector frame, the tool frame and the object frame. Frames are denoted by $\{part1\}$.

A **Pose** or **Transformation** describes the **position** and **orientation** of one frame with respect to another frame and is denoted by $T_{\{part1\}}^{\{part2\}}$.



Note that for the rotational part of a transformation there are multiple existing representations (Euler angles, quaternions, angle-axis, ...). For each different robot type, Pick-it™ communicates the rotation according to the convention of that robot.

5 Region of interest



The first step in the object localisation pipeline is to define all points of interest in the incoming point cloud. There are different filters available to remove uninteresting points based on their location wrt. a box, a plane, a sphere and points.

Pick-it™ will only correctly localize objects that are located within the region of interest. **Note** also that the region of interest parameters are stored in the Pick-it™ **setup**.

The major element of the Pick-it™ region of interest is a region with the shape of a 3D box. The **box-based** region of interest filter, removes all points located outside of that box. The dimensions of the region of interest box are defined with respect to the **Pick-it™ reference frame**, which in turn is defined with respect to the **camera frame**. Three methods are provided to teach the region of interest box's position and orientation with respect to the camera:

- **Use markers:** this method uses 2D markers.
- **Use plane:** this method looks for the most dominant plane in the entire field of view of the 3D camera.
- **Use camera:** this method takes the camera frame as the Pick-it™ reference frame.

The dimensions of the region of interest box are either taught with the markers or defined manually. The bottom and height of the region of interest is always specified manually.

Next to the box-based region of interest filter, there are also:

- a **Color** filter: this removes or keeps all points that are similar to a selected base color. The degree of similarity depends on the specified threshold.

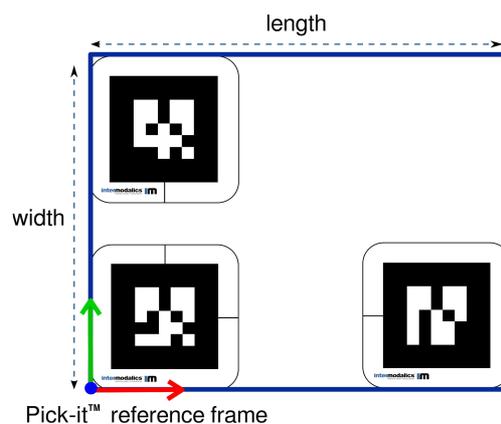
- a **Plane-based** region of interest filter: this filter removes all points located under the dominant plane in the region of interest box. This plane is defined in an image of the empty workspace.
- a **Point-based** region of interest filter: this filter removes all points located close to a point present in an image of the empty workspace.
- a **Sphere-based** region of interest filter: this filter removes all points located outside the dominant spherical shape found in the region of interest box.

5.1 Box-based region of interest filtering

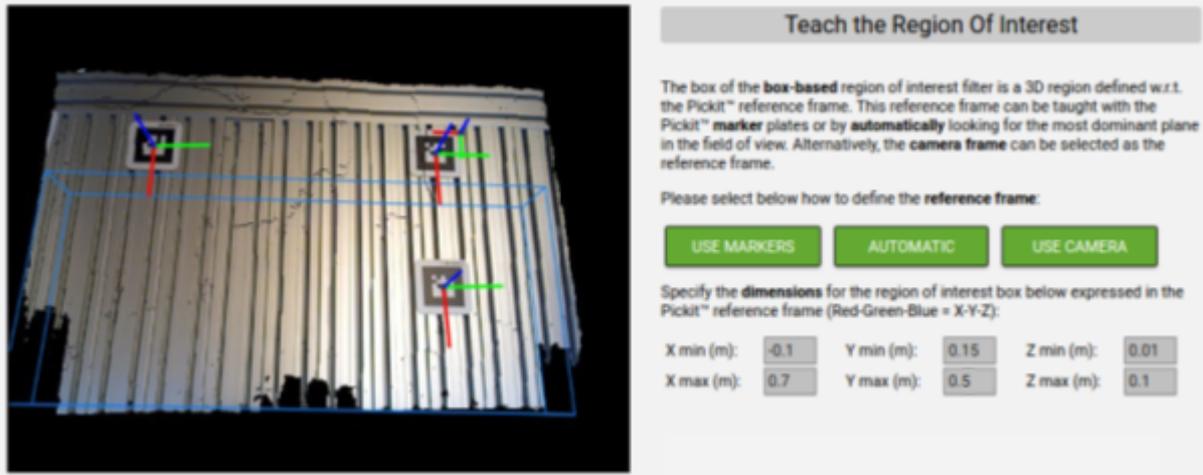
The box-based region of interest filtering removes all points in the pointcloud that are located outside of the region of interest box. The initialisation of the box-based region of interest filtering consists of defining the Pick-it™ reference frame and the box dimensions w.r.t. to this frame.

5.1.1 Marker-based teaching

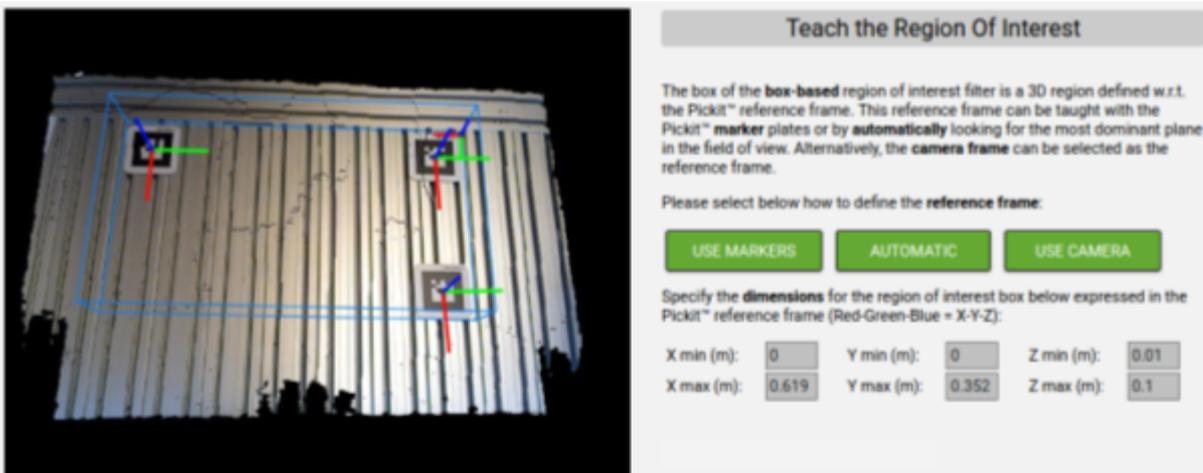
- Go to the *Region of Interest* menu of the Pick-it™ user interface.
- Position the three markers as shown in the image below:



- make sure all three markers are recognised. Only in this case, the USE MARKERS button will be enabled.
- the **centers of the three markers** will define the Pick-it™ reference frame with respect to the 3D camera.
- the distance between the marker plates will define the length and width of the region of interest box



- After positioning the markers, press the USE MARKERS button. The region of interest box is now being (re)defined. Make sure the markers are not moving with respect to the camera.
 - After less than 10 seconds the redefined region of interest box is visible in the camera image and a pop up will confirm for success.



- This method updates the positive and negative borders of the region of interest box along the X- and Y-axis. These values can still be manually adjusted after using the markers. The borders along the Z-axis always have to be manually adjusted.

5.1.2 Plane-based teaching

- Go to the *Region of interest* menu of the Pick-it™ user interface.
- Press the USE PLANE button. A pop-up dialog requests a value for the length and the width of the region of interest. The unit is indicated in the input field.
- After having set this value, press 'CONTINUE'. The region of interest box is now being redefined:
 - With this method, the position and orientation of the Pick-it™ reference frame are automatically defined by Pick-it™ based on the **dominant plane in the entire field of view** of the 3D camera.
- After less than 1 second the redefined region of interest box will be visible in the camera image.
- This method sets the positive and negative borders of the region of interest box along the X- and Y-axis to the value specified in the pop-up dialog. These values can still be manually adjusted after using the method. The borders along the Z-axis always have to be manually adjusted.

5.1.3 Camera-based teaching

- Go to the Region of interest menu of the Pick-it™ user interface.
- Press the USE CAMERA button. A pop-up dialog requests a value for the length and the width of the region of interest. The unit is indicated in the input field.
- After having set this value, press 'CONTINUE'. The region of interest box is now being redefined:
 - This method simply defines the **camera frame as the Pick-it™ reference frame**.
- This method sets the positive and negative borders of the region of interest box along the X- and Y-axis to the value specified in the pop-up dialog. These values can still be manually adjusted after using the method. The borders along the Z-axis always have to be manually adjusted.

5.2 Point-based region of interest filtering

The point-based region of interest filter removes all points located close to a point present in an image of the empty workspace. The initialisation of the point-based region of interest filtering consists of capturing a reference image of the **empty** workspace.

- Go to the *Region of interest* menu of the Pick-it™ user interface.
 - Remove all products to be picked from the workspace.
 - Press the TEACH WORKSPACE button. A pop-up dialog will tell which filters have been successfully initialised.
-

5.3 Plane-based region of interest filtering

The plane-based region of interest filtering removes all points in the pointcloud that are located below the region of interest plane. The initialisation of the plane-based region of interest filtering consists of capturing a reference image of the **empty** workspace and finding the dominant plane through all points within the above defined region of interest box.

- Go to the *Region of interest* menu of the Pick-it™ user interface.
- Remove all products to be picked from the workspace.
- Press the TEACH WORKSPACE button. A pop-up dialog will tell which filters have been successfully initialised.

The plane-based region of interest **filter** has **no** relation to the USE PLANE **method for teaching** the Pick-it™ reference frame.

5.4 Sphere-based region of interest filtering

The sphere-based region of interest filtering removes all points in the pointcloud that are located outside the dominant spherical shape found in the region of interest box. The initialisation of the sphere-based region of interest filtering consists of capturing a reference image of the **empty** workspace and finding the dominant sphere through all points within the above defined region of interest box.

- Go to the *Region of interest* menu of the Pick-it™ user interface.
- Remove all products to be picked from the workspace.
- Press the TEACH WORKSPACE button. A pop-up dialog will tell which filters have been successfully initialised.

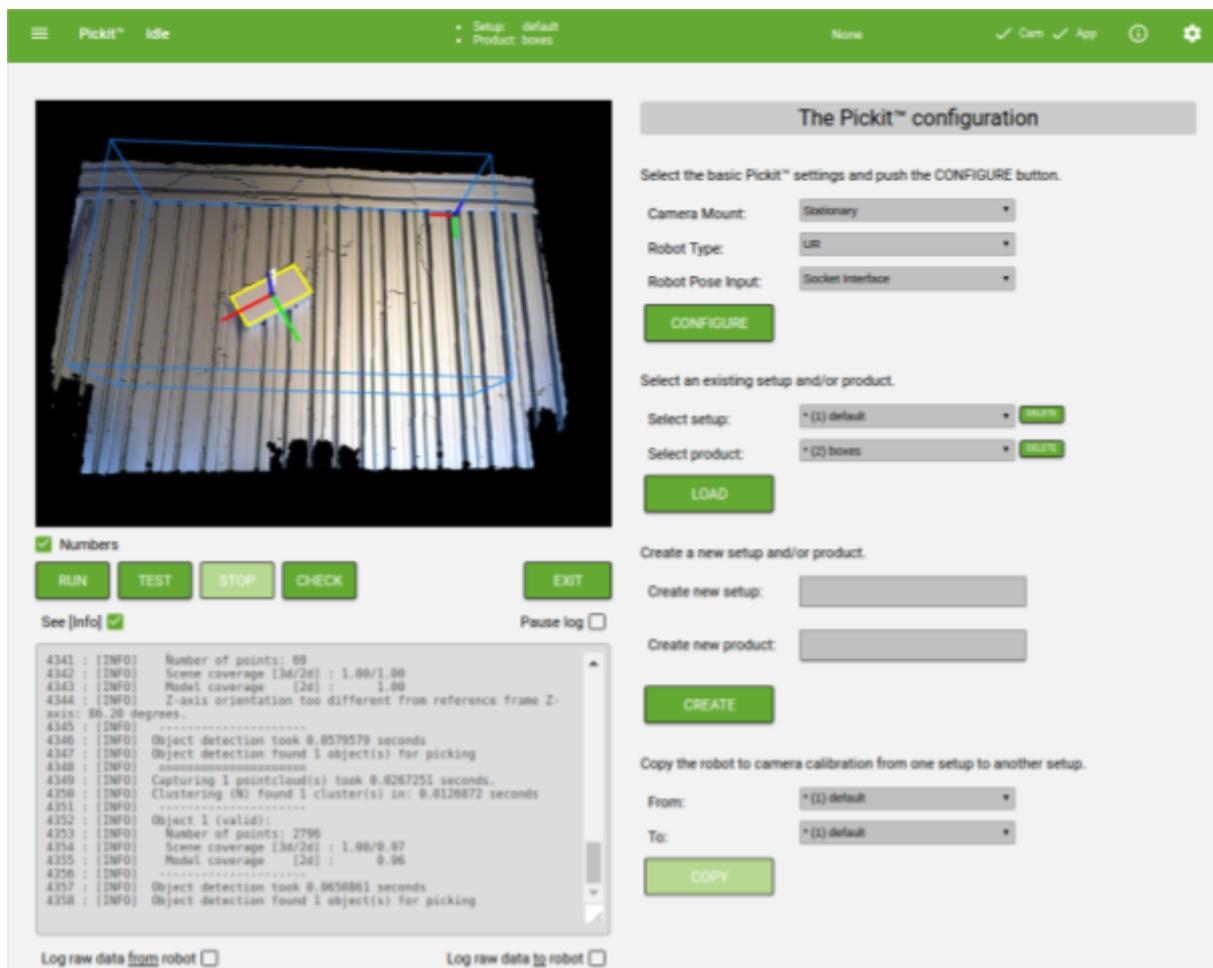
5.5 Adaptive box-based region of interest filtering

The adaptive box-based region of interest filtering removes all points in the pointcloud that are located a threshold distance below the highest point in the region of interest box. Located below, refers here to points that have a smaller value for their z-coordinate when taking the Pick-it reference frame as reference. The use of this filter requires no additional initialisation.

5.6 Testing your setup

Once the region of interest has been set up, you can test the new configuration easily by first verifying if a test product is *seen* by Pick-it™ and then localizing the test product:

1. Place a box-shaped object in the region of interest, which does not cross the edges of the blue region of interest box.
2. Select the “boxes” **product** type in on the CONFIGURATION page.
3. Push the CHECK button.
 - a. If the localization is successful, details about the object detection, such as the number of detected objects and the detection time, are displayed in the viewer.

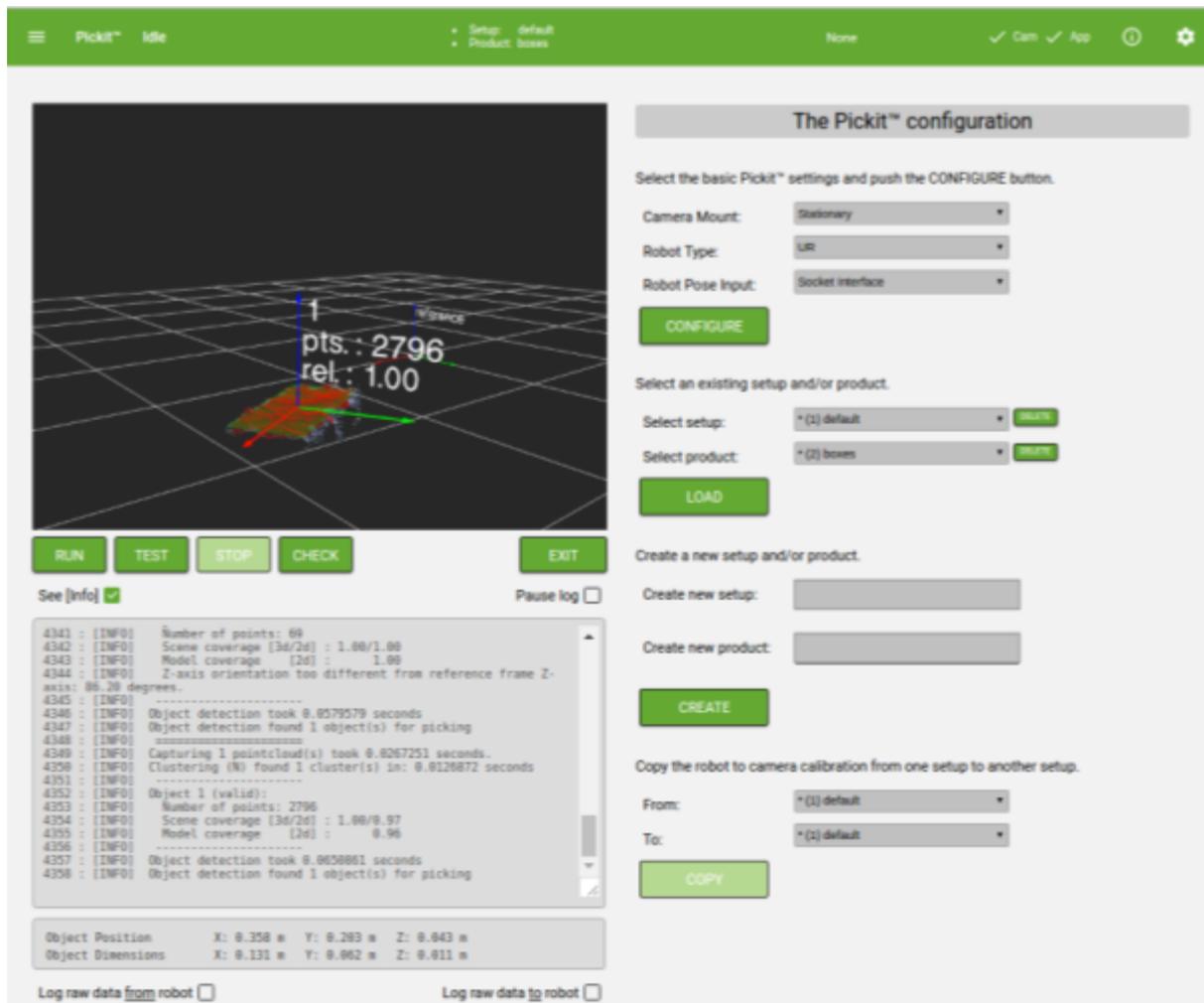


The screenshot displays the Pickit™ software interface. At the top, a green header bar shows 'Pickit™ Idle', 'Setup: default', 'Product: boxes', 'None', and status icons for 'Cam', 'App', and settings. The main interface is divided into several sections:

- Camera View:** A central window showing a camera feed of a white box on a dark surface. A blue wireframe bounding box is drawn around the box, and a yellow box with red and green axes is overlaid on it.
- Configuration Panel:** Titled 'The Pickit™ configuration', it includes:
 - Buttons: RUN, TEST, STOP, CHECK, EXIT.
 - Checkboxes: 'Numbers' (checked), 'See [Info]' (checked), 'Pause log' (unchecked), 'Log raw data from robot' (unchecked), 'Log raw data to robot' (unchecked).
 - Log Window: A scrollable text area showing system logs. Key entries include:


```
4341 : [INFO] Number of points: 69
4342 : [INFO] Scene coverage [36/24] : 1.00/1.00
4343 : [INFO] Model coverage [24] : 1.00
4344 : [INFO] Z-axis orientation too different from reference frame Z-axis: 86.29 degrees.
4345 : [INFO] -----
4346 : [INFO] Object detection took 0.0579579 seconds
4347 : [INFO] Object detection found 1 object(s) for picking
4348 : [INFO] =====
4349 : [INFO] Capturing 1 pointcloud(s) took 0.0267251 seconds.
4350 : [INFO] Clustering (N) found 1 cluster(s) in: 0.0126872 seconds
4351 : [INFO] -----
4352 : [INFO] Object 1 (valid):
4353 : [INFO] Number of points: 2796
4354 : [INFO] Scene coverage [36/24] : 1.00/0.97
4355 : [INFO] Model coverage [24] : 0.96
4356 : [INFO] -----
4357 : [INFO] Object detection took 0.0658861 seconds
4358 : [INFO] Object detection found 1 object(s) for picking
```
- Configuration Panel (Right):**
 - Section: 'The Pickit™ configuration'.
 - Text: 'Select the basic Pickit™ settings and push the CONFIGURE button.'
 - Fields: Camera Mount (Stationary), Robot Type (UR), Robot Pose Input (Socket Interface).
 - Button: CONFIGURE.
 - Section: 'Select an existing setup and/or product.'
 - Fields: Select setup (* (1) default), Select product (* (2) boxes).
 - Buttons: LOAD, CREATE.
 - Section: 'Create a new setup and/or product.'
 - Fields: Create new setup, Create new product.
 - Section: 'Copy the robot to camera calibration from one setup to another setup.'
 - Fields: From (* (1) default), To (* (1) default).
 - Button: COPY.

4. In the left menu, under “Views”, select “Valid objects”.
 - a. A 3D view showing the detected points of valid objects is shown.
 - b. The position and dimensions of the objects are displayed on the logger section below the viewer and a frame is projected onto the localized object. Note that the object position displayed at the bottom of the web page is the position with respect to the Pick-it™ reference frame.



The screenshot displays the Pickit™ web interface. At the top, there is a green navigation bar with a menu icon, the text 'Pickit™ Idle', and status indicators for 'Setup: default', 'Product: boxes', 'None', 'Cam', 'App', and a settings gear icon.

The main area is divided into two sections:

- 3D Viewer:** On the left, a 3D point cloud of an object is shown on a grid. A red frame is projected onto the object. Text overlaid on the object reads 'pts.: 2796' and 'rel.: 1.00'. Below the viewer are buttons for 'RUN', 'TEST', 'STOP', 'CHECK', and 'EXIT'.
- The Pickit™ configuration:** On the right, a panel titled 'The Pickit™ configuration' contains several sections:
 - Select the basic Pickit™ settings and push the CONFIGURE button.** This section includes dropdown menus for 'Camera Mount' (Stationary), 'Robot Type' (UR), and 'Robot Pose Input' (Socket interface), followed by a green 'CONFIGURE' button.
 - Select an existing setup and/or product.** This section includes dropdown menus for 'Select setup:' (*(1) default) and 'Select product:' (*(2) boxes), each with a green 'VALIDATE' button, and a green 'LOAD' button.
 - Create a new setup and/or product.** This section includes input fields for 'Create new setup:' and 'Create new product:', followed by a green 'CREATE' button.
 - Copy the robot to camera calibration from one setup to another setup.** This section includes dropdown menus for 'From:' (*(1) default) and 'To:' (*(1) default), followed by a green 'COPY' button.

At the bottom left, there is a log window with a 'See [info] ' button and a 'Pause log ' button. The log contains the following text:

```

4341 : [INFO] Number of points: 89
4342 : [INFO] Scene coverage [36/2d] : 1.00/1.00
4343 : [INFO] Model coverage [2d] : 1.00
4344 : [INFO] Z-axis orientation too different from reference frame Z-
axis: 86.29 degrees.
4345 : [INFO] -----
4346 : [INFO] Object detection took 0.0579579 seconds
4347 : [INFO] Object detection found 1 object(s) for picking
4348 : [INFO] =====
4349 : [INFO] Capturing 1 pointcloud(s) took 0.0267251 seconds.
4350 : [INFO] Clustering (W) found 1 cluster(s) in: 0.0126872 seconds
4351 : [INFO] -----
4352 : [INFO] Object 1 (valid):
4353 : [INFO] Number of points: 2796
4354 : [INFO] Scene coverage [36/2d] : 1.00/0.97
4355 : [INFO] Model coverage [2d] : 0.96
4356 : [INFO] -----
4357 : [INFO] Object detection took 0.0620861 seconds
4358 : [INFO] Object detection found 1 object(s) for picking
  
```

Below the log, there is a table showing object position and dimensions:

Object Position	X: 0.358 m	Y: 0.283 m	Z: 0.043 m
Object Dimensions	X: 0.131 m	Y: 0.062 m	Z: 0.011 m

At the bottom, there are two checkboxes: 'Log raw data from robot ' and 'Log raw data to robot .

6 Robot-Camera Calibration

To use Pick-it in combination with a robot or machine, a robot-camera calibration procedure has to be performed. The resulting robot-camera calibration parameters define where the camera is located with respect to the robot and as such, they allow Pick-it to provide object locations with respect to the robot base frame.

The calibration parameters are **stored in the current setup file** on the Pick-it™ processor when explicitly being saved. Recalibration is only required when the camera is moved or rotated with respect to the robot.

WARNING Wrong or old calibration parameters can lead to unexpected motions. Safe motions of the robot must always be checked by the operator of the robot itself and can never be guaranteed by Pick-it™.

Head over to the Pick-it knowledge base for a quick start guide on robot-camera calibration: <http://support.pickit3d.com/calibration>

7 Object pick positions

The purpose of this Chapter is to describe the relation between the object pose communicated to the robot and the actual required motion of the robot end-effector. Implementing this relation correctly is not the responsibility of the Pick-it™ software but of the robot side program.

7.1 General relation

In order to move your robot into the correct position for picking, the following has to be taken into account:

- **The Object frame** $\{Obj\}$: Pick-it™ communicates the pose of the localized objects with respect to the robot base frame. Object frames for different object types are discussed in Section [7.2](#).
- **The Pick-up frame** $\{Obj'\}$: The position where and direction in which an object needs to be picked does not necessarily correspond to the object frame.
- **The Tool frame** $\{tool\}$: Due to the dimensions of the tool, the tool frame does not correspond to the robot end-effector frame $\{ee\}$.

To pick an object, the tool frame has to correspond to the object Pick-up frame:

$$\{tool\} = \{Obj'\}$$

To get the desired robot end-effector pose, the incoming object pose has to be compensated by the transformation from the object to the Pick-up frame and the transformation from the end-effector to tool frame:

$$T_{\{base\}}^{\{ee\}} = T_{\{base\}}^{\{Obj\}} \times T_{\{Obj\}}^{\{Obj'=tool\}} \times T_{\{ee\}}^{\{tool\}}^{-1}$$

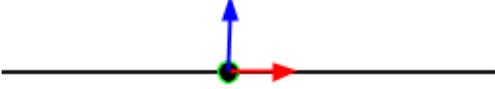
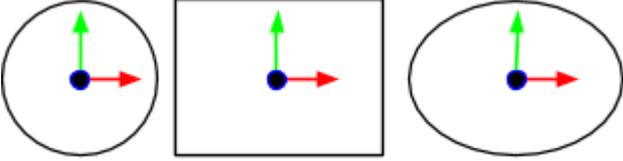
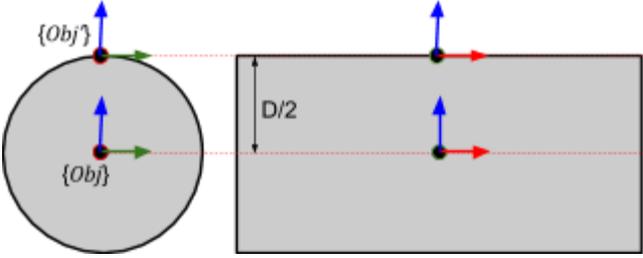
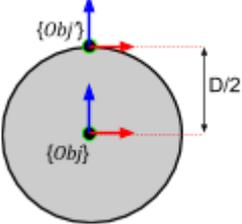
with:

- $T_{\{base\}}^{\{ee\}}$: is the Robot End-Effector Pose expressed in Robot Base frame
- $T_{\{base\}}^{\{Obj\}}$: is the Object Pose expressed in Robot Base frame
- $T_{\{Obj\}}^{\{Obj'=tool\}}$: is the Pick-up Pose expressed in Object Pose frame
- $T_{\{ee\}}^{\{tool\}}^{-1}$: is the inverse (-1) of the Tool Offset frame

Every robot type has different ways to define (parts of) these transformations. Pick-it™ comes with a robot program file which can do these calculations for your specific robot type.

7.2 Pick-it Object Poses

Pick-it™ communicates the pose of the found objects with respect to the robot base frame. How the object frames $\{Obj\}$ are defined depending on the object type is shown here. Furthermore, for the case that the object is picked from the top with a vacuum suction pad, the logical Pick-up frame $\{Obj'\}$ is given for each object type.

<p>3D Plane The object frame is located in the center of the planar surface (the 'centroid'). The X-axis points in the longest direction of the surface, while the Z-axis points upwards.</p> <p>The pick-up frame can be the same as the object frame.</p>	 <p style="text-align: center;">$\{Obj'\} = \{Obj\}$</p>
<p>3D Plane + 2D Circle, Rectangle, Square, Ellipse The object frame is located in the center of the planar shape, where the edges of the 3D plane are used to determine its size. For rectangles and ellipses, the X-axis points in the longest direction of the surface. The Z-axis always points upwards.</p> <p>The pick-up frame can be the same as the object frame.</p>	 <p style="text-align: center;">$\{Obj'\} = \{Obj\}$</p>
<p>3D Cylinder The object frame is located in the center of the cylinder. The X-axis points in the longitudinal direction of the cylinder. For the Y- and Z-axis the orientation is configuration dependent.</p> <p>The radius of the cylinder can be used as offset to define the pick-up frame. Pick-it uses diameter (D) values, so it needs to be divided by 2.</p>	
<p>3D Ball The object frame is located in the center of the ball. For the X-, Y- and Z-axis orientation is configuration dependent.</p> <p>The radius of the ball can be used as offset to define the pick-up frame. Pick-it uses diameter (D) values, so it needs to be divided by 2.</p>	

8 Robotic picking programs

WARNING Before starting to pick objects, the robot-camera calibration has to be done correctly. See Section [6.5](#) for more details on how to verify the robot-camera calibration.

WARNING Successful picking requires correct values for the object to end-effector transformation. The latter is the responsibility of the robot or machine program.

Pick-it™ has to be in the **Running** state before robot commands can be received and object data can be sent.

For every supported robot brand we include an example program in the robot files folder for the brand.

You can find all **robot specific files** here:

<http://support.pickit3d.com/robot-files>

WARNING Changing the any other files than the calibration or robot program files should not be required. Please don't edit these scripts because you may receive updates of these scripts and there is the possibility of braking something.

We provide an extensive step-by-step guide on **scripting a robot program with Pick-it** on:

<http://support.pickit3d.com/article/32-example-case-picking-and-orientating-cups>

Additionally you can find the Pick-it **functions cheat sheet** on:

<http://support.pickit3d.com/article/50-the-pick-it-functions-cheat-sheet>

9 Pick-it 3D Camera

The Pick-it™ 3D camera is a real-time structured light camera with additional RGB sensor capabilities.

This enables Pick-it to find **overlapping products of varying sizes**, all colors **matte and glossy** and **all materials** also with **reflective surfaces** and **keeps working even in changing and poor light** conditions.

9.1 Pick-it 3D Camera specifications

Camera Type: Short Range - Long Range

The Pick-it camera can be either long range or short range. While the long range is recommended for picking applications of products of size 50 x 50 x 50 mm and larger, the short range camera suits better for products of size 20 x 20 x 20 mm and larger.

Please consult your assigned Pick-it application engineer for choosing the right camera and defining the camera set-up in case your products are smaller.

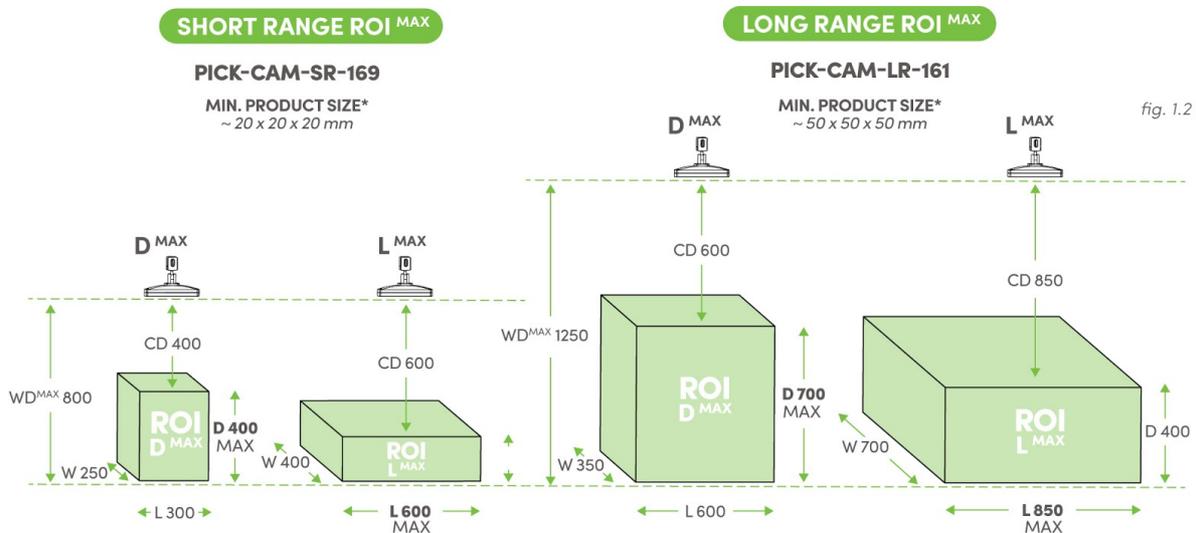


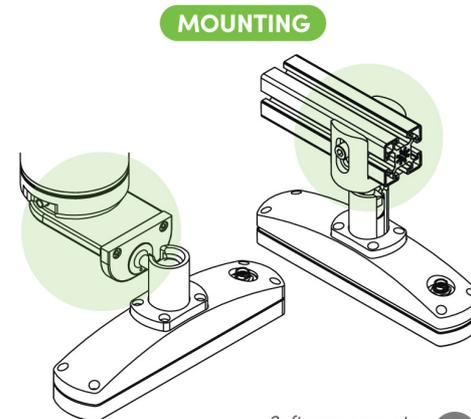
fig. 1.2

VISION RANGE SPECIFICATIONS				
MODEL	SHORT RANGE CAMERA		LONG RANGE CAMERA	
CAMERA REFERENCE	PICK-CAM-SR-169		PICK-CAM-LR-161	
MAX. WORKING DISTANCE (WD ^{MAX})	800		1250	
MIN. PRODUCT SIZE*	~ 20 x 20 x 20 mm		~ 50 x 50 x 50 mm	
	*Contact us for smaller sizes.			
MAX. REGION OF INTEREST	D ^{MAX}	L ^{MAX}	D ^{MAX}	L ^{MAX}
ROI LENGHT (L) X WIDTH (W)	300 X 250	600 X 400	600 X 350	850 X 700
ROI DEPTH (D)	400	200	700	400
CAMERA DISTANCE (CD)	400	600	600	850

9.2 Pick-it 3D Camera set-up capabilities

Camera Mounting

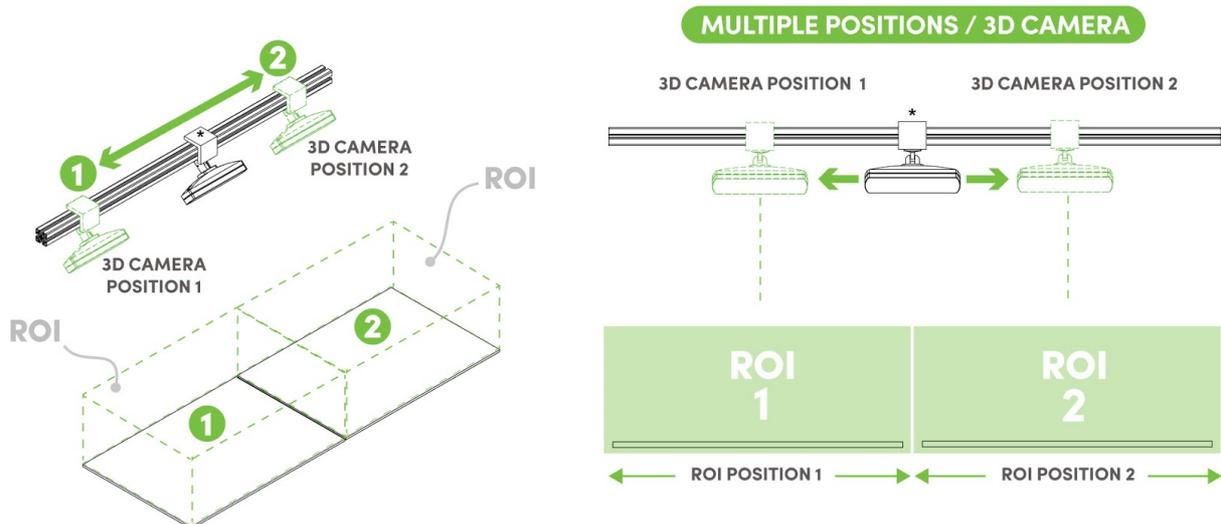
The Pick-it software supports both on-robot mounting and fixed mounting.



Software supports **ON-ROBOT MOUNTING*** & **STATIONARY MOUNTING*** 
**A wide range of robot flanges and profile types is supported. Contact us for further information.*

Multiple View Areas

The Pick-it software supports the option to pick multiple products from different locations with 1 camera. For this configuration the camera is to be mounted on a robot or linear sledge to enable multiple camera positions.

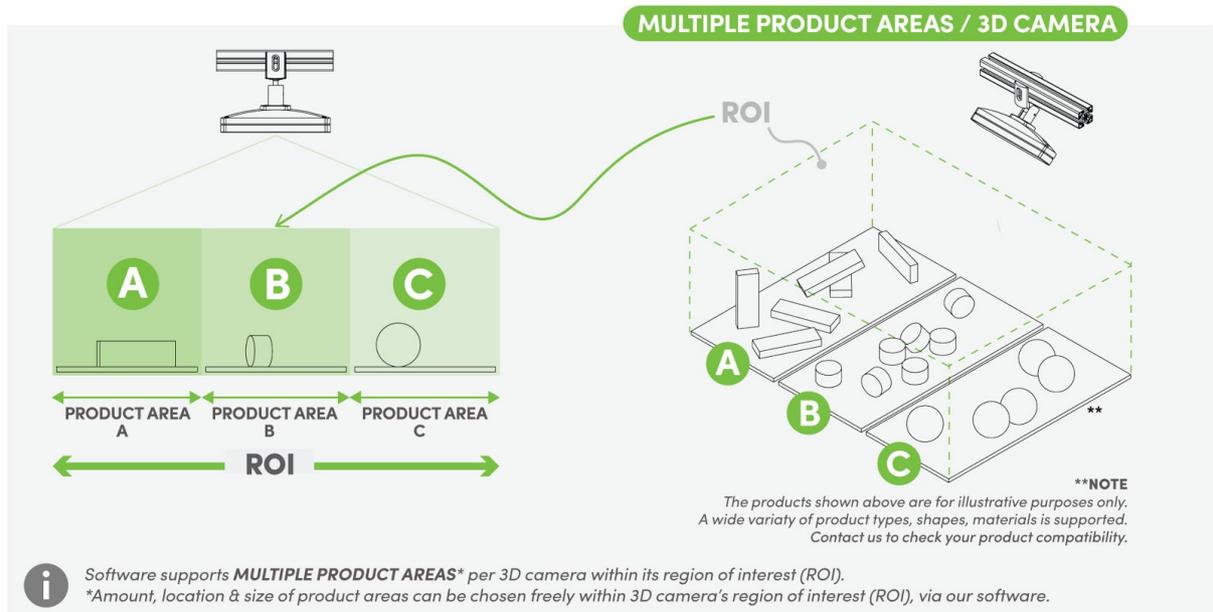


 Software supports **MULTIPLE LINEAR 3D CAMERA POSITIONS*** per 3D camera when mounted on a linear sledge.
**Amount & location of 3d camera positions can be chosen freely.*

Multiple Product Areas

The Pick-it software also supports different Product Areas within the same View Area. This can be very useful for picking different products (A, B, C, ...) in a sequential order for a kitting application.

In this configuration, multiple 'region of interests' can be defined using the location markers.



9.3 Environmental and Operating Conditions

Device	Temperature	Vibrations	IP rating	Power supply	Humidity
Standard Processor	-20°C to 70°C	Operating, 5 Grms, 5-500 Hz, 3 axes	IP54	9-32V DC 160W	~95% @ 40°C (non-condensing)
Standard 3D Camera	10°C to 30°C	Operating, 2 Grms, 5-500 Hz, 3 axes	IP55	USB3 5VDC	~95% @ 40°C (non-condensing)

Environmental and Operating Conditions may vary on the delivered 3D Camera and Vision Processor in case the standard components are not used.

Please check with your Pick-it™ sales representative for devices with different operating conditions.

10 Annex 1: Cabling and powering for FLEX and TEACH processors

The purpose of this annex is to complement Chapter [Installation and Setup](#), in particular Section [Connecting Pick-it](#). Depending on the application goal, Pick-it works on two different computers, namely FLEX and TEACH systems. This annex shows the positioning of the labelled ports for each processor.

Pick-it	FLEX	TEACH
Number cores	8	12
Processor speed	2.8 GHz	3.5 GHz
Camera interface	Industrial USB	Industrial USB
Robot interface	Ethernet	Ethernet
Dimensions (Length X Width x Height)	74 x 192 x 230 mm	482 x 88 x 480 mm
Voltage	9 - 36 V DC	100 - 240 V AC

10.1 FLEX processor

FLEX processors have I/O ports at the front and back sides. The camera USB port, the interface and the robot ethernet ports, as well as the power button, are placed at the front and the side.

The LAN and service ethernet ports and the power connector are located at the back side of the computer.

In order to plug the processor to a power supply, use the provided power adapter or use the supplied connector and a DC (9 - 32 V) power supply. In case the computer is on and there is a power failure, it will restart automatically when power is restored.

10.2 TEACH processor

WARNING In case the TEACH processor is positioned vertically and sideways, the air inlet shall not stay at the top, as this affects the ventilation process.

The front side of the TEACH processor contains a lid, which can be opened by rotating the closure clockwise.



A few ports (which are not used with Pick-it™) and some buttons are located under the lid. The power switch is highlighted by a red circle below. In case of a power failure while the computer is on, it will restart automatically when power is restored.



All labelled I/O ports and the power connector are placed at the back side of the box, shown below. In order to connect the TEACH computer to a power supply, use the provided IEC cable.

11 Warranty

Pick-it warrants the Robotic Vision System Pick-it against defects in material and workmanship for a period of one year from the date of reception when utilized as intended with the specified maintenance. Pick-it also warrants that this equipment will meet applicable specifications under normal use.

Warranty applies under the following conditions:

- Usage respects the operating, transporting and storage conditions specified in Section 9.3

During the warranty period, Pick-it will repair or replace any defective product, as well as verify and adjust the product free of charge if the equipment should need to be repaired or if the original adjustment is erroneous. If the equipment is sent back for verification during the warranty period and found to meet all published specifications, Pick-it will charge standard verification fees.

The unit is considered defective when at least one of the following conditions occurs:

- The Camera-to-Robot interface is not accessible or does not respond
- The Robot-to-Camera calibration fails while calibration plate is within specified field of view
- The Workspace calibration fails while the workspace markers are within the specified field of view

The warranty will become null and void if the:

- Unit has been tampered with, repaired or worked on by unauthorized individuals.
- Warranty sticker on processor has been removed or is broken.
- Screws, other than as explained in this guide, have been removed.
- Calibration seal on camera is broken.
- Unit has been opened.
- Unit serial number has been altered, erased, or removed.
- Unit has been misused, neglected, or damaged by accident.

This warranty is in lieu of all other warranties expressed, implied, or statutory, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. In no event shall Pick-it be liable for special, incidental, or consequential damages.

Pick-it shall not be liable for damages resulting from the use of the product, nor shall be responsible for any failure in the performance of other items to which the product is connected or the operation of any system of which the product may be a part.

Exclusion

Pick-it reserves the right to make changes in the design or construction of any of its products at any time without incurring an obligation to make any changes whatsoever on units already purchased.

This warranty excludes failure resulting from: improper use or installation, normal wear and tear, accident, abuse, neglect, fire, water, lightning or other acts of nature, causes external to the product or other factors beyond Pick-it control.

12 Contact

Technical Support

Knowledge base : <http://support.pickit3d.com/>

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